The infection of tench (*Tinca tinca)* with *Ligula intestinalis* plerocercoids in Lake Beysehir (Turkey)

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Abstract

Tench (*Tinca tinca*) were sampled between October 2002 and February 2003 in Lake Beysehir and examined for *Ligula intestinalis* plerocercoid infestation. Prevalence ranging from 41.66% ± 8.33 to 84.52 ± 1.19, decreased with increasing fish size. Index of parasitization (I_p) did not differ among the fish length classes however, monthly fluctations in I_p were significant. Minimum I_p value was recorded as 2.72 ± 0.30 in October and maximum I_p 5.55 ± 0.49 in February. There were no consistent trends in plerocercoid weight in relation to fish weight. Mean intensity levels did not vary in the length classes of fish. No significant differences were observed in mean intensity levels in the months studied except in February.

Introduction

Tench (*Tinca tinca* L.*)* is of great economic importance for the fisheries of Lake Beysehir, Anatolia. In Turkey, the domestic consumption of tench is almost zero, however filleted catches are exported to the USA and Europe.

Ligula intestinalis is a widespread and common parasite of cyprinid fish in continental Europe and North America (Kennedy and Burrough, 1981). It has also been isolated from the non-cyprinid stone loach *Barbatula barbatulus* (Bean and Kirkwood, 1997). *L. intestinalis* is a pseudophyllidean tapeworm with a three-host life cycle involving copepods, fish and piscivorous birds. In terms of longevity and host involvement, the plerocercoid occuring in the body cavity of fish is the dominant phase of the life cycle (Hoole and Arme, 1983; Williams *et al*., 1998). It is known that larval cestode *Ligula* cause pressure atrophy of ovaries and a heavy ectoparasitic load may inhibit proper maturation of eggs (Ferguson, 1989). Fish infected with *L. intestinalis* may therefore be unable to reproduce (Williams *et al*., 1998).

In Turkey, the plerocercoids of *L. intestinalis* have been previously recorded for some fish species such as *Alburnis orontis and Leuciscus cephalus* in Almus Dam Lake (Cengizler *et al*.1991) and *Tinca tinca* in Lake Mogan (Oge and Aydin, 1995).

Recently in Lake Beysehir, the infestation of tench with the cestode *L.intestinalis* was observed where there has been no previous report of the occurrence of *L. intestinalis*. The purpose of the present study was to analyse the actual prevalence and intensity of infection with *L. intestinalis* in tench from Lake Beysehir over a period of 5 months.

Length classes (cm)	Months										P ± S.E.
	October		November		December		January		February		
	N	P(%)	N	P(%)	N	P(%)	N	P(%)	N	P(%)	
16.5 - 20.4	-	-	7	85.71	6	83.33	-	-	-	-	84.52 ± 1.190[a*]
20.5 - 24.4	15	80.00	18	77.78	16	81.25	18	77.78	14	85.71	80.50 ± 1.462[a]
24.5 - 28.4	15	66.67	13	61.54	10	70.00	5	80.00	19	68.42	69.33 ± 3.024[b]
28.5 - 32.4	11	45.45	7	57.14	6	60.00	6	50.00	4	50.00	52.52 ± 2.465[c]
32.5 - 36.4	3	33.33	2	50.00	4	50.00	5	40.00	2	50.00	44.67 ± 3.432[c]
36.5 - 40.4	-	-	-	-	3	33.33	4	50.00	-	-	41.66 ± 8.335[d,c]

Table 1. Prevalence (P) of *L. intestinalis* plerocercoids in different length classes of tench (N=number of fish examined). *Values with different superscripts in a column indicate significant differences ($p<0.05$).

Materials and Methods

Tench (*T. tinca)* in Lake Beysehir were obtained monthly from commercial suppliers between October 2002 and February 2003. Lake Beysehir is one of the largest lakes in Anatolia with a surface area of 650 km^2. During the study period a total of 203 tench were examined for length, weight and presence of *L. intestinalis* plerocercoids. Data were also recorded on the numbers and individual weights of plerocecoids.

A feature of infections with ligulid plerocercoids is the large relative weight of parasite to host tissue. This is expressed in the parasitic index as stated by Arme and Owen (1968). Parasitic index (I_p) was used in assessing the intensity of infection for each fish: $I_p=100W_p.W^{-1}$, where W_p is the parasite mass and W is the host mass. Prevalence (%) and mean intensity levels of parasites were determined according to Bush *et al.* (1997).

In the presentation of data on infections the fish were classified into groups according to their length. Data obtained were analyzed using G-statistics for prevalence and ANOVA for the parasitic index, mean intensity levels and plerocercoid weight within each of the fish length classes. The relationship between fish weight and plerocercoid weight was analyzed using linear regression.

Results

The external appearance of infected tench was normal and showed no distension of the body. However, the plerocercoids of *L. intestinalis* became coiled around the viscera and occluded the body cavity.

The prevalence of the plerocercoids in tench were compared within each length class and for the months studied (Table 1). The prevalence differed significantly among the length classes ($p<0.05$). The prevalence of infection, in general, decreased with increasing fish size. The maximum prevalence was recorded as 85.71 % in the length classes of 16.5-20.4 cm in November and 20.5-24.4 cm in February. The minimum prevalence level was found to be 33.33 % in the 32.5-36.4 cm length class in October and the 36.5-40.4 cm length class in December. However, when the months were

Length classes (cm)	Months				
	October	November	December	January	February
	Mean ± S.E. (Min. - Max.)	Mean ± S.E. (Min. - Max.)	Mean ± S.E. (Min. - Max.)	Mean ± S.E. (Min. - Max.)	Mean ± S.E. (Min. - Max.)
16.5 - 20.4	-	3.73 ± 0.93 (1.30 - 7.92)	4.57 ± 1.01 (1.83 - 7.76)	-	-
20.5 - 24.4	2.73 ± 0.64 (0.54 - 6.52)	3.40 ± 0.65 (1.31 - 9.70)	4.37 ± 0.60 (1.80 - 9.94)	3.71 ± 0.48 (0.36 - 6.79)	5.35 ± 0.91 (1.47 - 12.57)
24.5 - 28.4	2.81 ± 0.34 (0.65 - 3.85)	4.23 ± 0.56 (2.39 - 7.03)	3.34 ± 0.51 (1.96 - 5.91)	4.30 ± 1.74 (2.50 - 9.46)	6.24 ± 0.93 (2.49 - 10.74)
28.5 - 32.4	2.52 ± 0.54 (0.74 - 3.80)	3.17 ± 1.10 (1.16 - 6.13)	2.72 ± 1.31 (0.85 - 5.26)	1.85 ± 0.55 (0.80 - 2.67)	3.75 ± 1.60 (2.15 - 5.36)
32.5 - 36.4	2.60	1.27	2.35 ± 0.87 (1.48 - 3.23)	0.93 ± 0.06 (0.87 - 0.99)	2.74
36.5 - 40.4	-	-	1.07	1.06 ± 0.53 (0.53 - 1.59)	-
Mean ± S.E. (Min.-Max.)	2.72 ± 0.30*^{bc} (0.54 - 6.52)	3.57 ± 0.33^{b} (1.16 - 9.70)	3.86 ± 0.48^{b} (0.85 - 9.94)	3.15 ± 0.44^{b} (0.53 - 9.46)	5.55 ± 0.49^{a} (1.47 - 12.57)

Table 2. Parasitization index (I_p) of *L. intestinalis* plerocercoids in different length classes of tench. *Values with different superscripts in a row indicate significant differences ($p<0.05$).

compared, no statistically significant differences in the prevalences between each host length class were observed ($p>0.05$).

Parasitic load presented as the parasitic index of tench did not differ among the length classes of fish ($p>0.05$) whereas for the months studied there were significant differences ($p<0.05$) (Table 2). The I_p values recorded for the study period were highest in February. Mean weight of *L. intestinalis* plerocercoids showed significant variations among the length classes of the hosts ($p<0.01$) and were highest in the length classes of 32.5-36.4 cm (Table 3). Nevertheless, there was no clear relationship between fish weight and plerocercoid weight ($R^2=0.44$).

Mean intensity levels showed no significant differences within the six different length groups ($p>0.05$) however, in relation to months studied there were significant variations in mean intensity levels ($p<0.05$) (Table 4). The maximum mean intensity levels were recorded in February.

Discussion

In this study carried out in Lake Beysehir, the prevalence of infection by plerocercoids of *L. intestinalis* in tench varying from 41.66% to 84.52% represents a high value. Prevalence decreased with increasing fish size, probably due to selective mortality among parasitized individuals, as was observed by Museth (2001). Alternatively, the lower prevalence of infection in larger fish may be a consequence of reduced consumption of infected copepods in older fish (Kennedy and Burrough 1981). The index of parasitization was recorded in relation to the length of their tench host. However, there was no correlation between the I_p observed and length of the host. In addition, there was no marked relationship between

Length classes (cm)	$\overline{W}_f \pm S_{\overline{W}_f}$ (Min.-Max.)	$\overline{W}_p \pm S_{\overline{P}_f}$ (Min.-Max.)
16.5 - 20.4	91.69 ± 4.76 (63.69 - 113.64)	1.06 ± 0.08 (0.38 - 2.33)
20.5 - 24.4	186.05 ± 3.09 (124.63-245.98)	1.81 ± 0.07 (0.26 - 5.56)
24.5 - 28.4	264.82 ± 7.43 (185.30 - 370.93)	2.20 ± 0.08 (0.41 - 8.89)
28.5 - 32.4	380.55 ± 15.23 (290.76 - 525.11)	2.70 ± 0.25 (0.50 - 8.95)
32.5 - 36.4	609.27 ± 29.02 (517.79 - 730.73)	3.17 ± 0.47 (0.95 - 9.10)
36.5 - 40.4	855.59 ± 19.78 (823.40 - 891.59)	2.35 ± 0.61 (0.07 - 6.63)

Table 3. Mean host (W_f, g) and plerocercoid weight (W_p, g) according to the length classes of fish.

host weight and parasite weight. The plerocerciods of *L. intestinalis* attain a large size relative to the host and infections frequently comprise more than a single plerocercoid. Thus, the insignificant variations in I_p irrespective of the length of the hosts are in accordance with this concept. Mean intensity values were similar in all months studied except February.

No previous surveys have been conducted on the distribution of *L. intestinalis* in Lake Beysehir. It is not possible, therefore, to compare the data obtained in this study. Furthermore, tench were only introduced into Lake Beysehir in the 1990's, representing a relatively recent addition to the inhabitants of the lake.

Length classes (cm)	Months				
	October	November	December	January	February
	Mean ± S.E. (Min.-Max.)	Mean ± S.E. (Min.-Max.)	Mean ± S.E. (Min.-Max.)	Mean ± S.E. (Min.-Max.)	Mean ± S.E. (Min.-Max.)
16.5 - 20.4	-	3.67 ± 0.49 (2 - 5)	5.20 ± 0.969 (2 - 7)	-	-
20.5 - 24.4	-	2.78 ± 0.42 (1 - 7)	4.38 ± 0.866 (1 - 13)	2.93 ± 0.29 (1 - 5)	5.75 ± 0.87 (1 - 10)
24.5 - 28.4	3.33 ± 0.35 (2 - 5)	4.12 ± 0.51 (2 - 6)	3.14±0.67 (1 - 6)	7.00 ± 2.80 (2 - 14)	6.54 ± 0.76 (5 - 14)
28.5 - 32.4	4.10 ± 0.46 (2 - 6)	4.00 ± 1.35 (2 - 8)	2.33 ± 0.82 (1 - 4)	3.67 ± 1.76 (1 - 7)	4.00 ± 0.00 (4 - 4)
32.5 - 36.4	4.40 ± 0.51 (3 - 6)	3.00	1.50 ± 0.50 (1 - 2)	2.50 ± 0.50 (2 - 3)	6.00
36.5 - 40.4	8.00	-	3.00	4.50 ± 1.50 (3 - 6)	-
Mean ± S.E. (Min. - Max)	3.96 ± 0.29*^{b} (2 - 8)	3.42 ± 0.29^b (1 - 8)	3.81 ± 0.46^b (1 - 13)	3.76 ± 0.56^b (1 - 14)	6.00 ± 0.517^a (1 - 14)

Table 4. Mean intensity levels of *L. intestinalis* plerocercoids in different length classes of tench. *Values with different superscripts in a row indicate significant differences ($p<0.05$).

The plerocercoids of *L. intestinalis* may normally be expected to have a negative influence on tench population in Lake Beysehir, and the prevalence of infection may increase with time. The immediate effects of *L. intestinalis* infection on tench were not assessed in the present study. Nevertheless, it is obvious that *L. intestinalis* plerocercoids can have dramatic effects on somatic and gonadal growth which may influence the population dynamics of tench. Hence, Kennedy and Burrough (1981) stated that *Ligula* has very rapid power of dispersal throughout a new host population. It can reduce the population density and allow the resumption of good growth rates. It may influence the whole balance of the fish population due to impaired competitive relations. This is of importance for Turkey when the economic aspects of fisheries income from tench export are considered.

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